UNITED STATES DEPARTMENT OF COMMERCE
Patent and Trademark Office
Address: COMMISSIONER OF PATENTS AND TRADEMARKS
Washington, D.C. 20231

APPLICATION NO.	FILING DATE	FIRST NAMED INVENTOR	ATTORNEY DOCKET NO.
08/897,839	07/21/97	NISHIMOTO	Y

EXAMINER	
EATON,K	
ART UNIT	**PAPER NUMBER**
2814	

DATE MAILED: 10/29/98

MM21/1029

LORUSSO & LOUD
3137 MT VERNON AVENUE
ALEXANDRIA VA 22305

Please find below and/or attached an Office communication concerning this application or proceeding.

Commissioner of Patents and Trademarks

Office Action Summary	Application No. 08/897,839	Applicant(s) Nishimoto et al.
	Examiner Kurt Eaton	Group Art Unit 2814

☒ Responsive to communication(s) filed on *Sep 18, 1998*.

☐ This action is **FINAL**.

☐ Since this application is in condition for allowance except for formal matters, **prosecution as to the merits is closed** in accordance with the practice under *Ex parte Quayle*, 1935 C.D. 11; 453 O.G. 213.

A shortened statutory period for response to this action is set to expire *3* month(s), or thirty days, whichever is longer, from the mailing date of this communication. Failure to respond within the period for response will cause the application to become abandoned. (35 U.S.C. § 133). Extensions of time may be obtained under the provisions of 37 CFR 1.136(a).

Disposition of Claims

☒ Claim(s) *1-20* is/are pending in the application.

Of the above, claim(s) _____ is/are withdrawn from consideration.

☐ Claim(s) _____ is/are allowed.

☒ Claim(s) *1-20* is/are rejected.

☐ Claim(s) _____ is/are objected to.

☐ Claims _____ are subject to restriction or election requirement.

Application Papers

☒ See the attached Notice of Draftsperson's Patent Drawing Review, PTO-948.

☐ The drawing(s) filed on _____ is/are objected to by the Examiner.

☐ The proposed drawing correction, filed on _____ is ☐approved ☐disapproved.

☐ The specification is objected to by the Examiner.

☐ The oath or declaration is objected to by the Examiner.

Priority under 35 U.S.C. § 119

☐ Acknowledgement is made of a claim for foreign priority under 35 U.S.C. § 119(a)-(d).

☐ All ☐ Some* ☐ None of the CERTIFIED copies of the priority documents have been

☐ received.

☐ received in Application No. (Series Code/Serial Number) _____.

☐ received in this national stage application from the International Bureau (PCT Rule 17.2(a)).

*Certified copies not received: _____.

☐ Acknowledgement is made of a claim for domestic priority under 35 U.S.C. § 119(e).

Attachment(s)

☒ Notice of References Cited, PTO-892

☒ Information Disclosure Statement(s), PTO-1449, Paper No(s). *3*

☐ Interview Summary, PTO-413

☒ Notice of Draftsperson's Patent Drawing Review, PTO-948

☐ Notice of Informal Patent Application, PTO-152

--- SEE OFFICE ACTION ON THE FOLLOWING PAGES ---

DETAILED ACTION

Priority

1. Receipt is acknowledged of papers submitted under 35 U.S.C. 119(a)-(d), which papers have been placed of record in the file.

Specification

2. The disclosure is objected to because of the following informalities: On page 8, lines 24-25, reference is made to a piece of scientific literature. The volume (vol.) number is incorrect, vol. 4 should read in place of vol. 14.

Appropriate correction is required.

Claim Rejections - 35 USC § 112

3. The following is a quotation of the second paragraph of 35 U.S.C. 112:

> The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention.

4. Claims 10, 11, and 14 are rejected under 35 U.S.C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

5. Claims 10 and 14 recite the limitation "said film forming condition of respective insulative films to adjust stress characteristics of respective insulating films" in lines 2-4 of both claims 10 and 14. There is insufficient antecedent basis for this limitation in the claim.

6. Claim 11 recites the limitation "plasmanization" in . There is insufficient antecedent basis for this limitation in the claim.

Claim Rejections - 35 USC § 102

7. The following is a quotation of the appropriate paragraphs of 35 U.S.C. 102 that form the basis for the rejections under this section made in this Office action:

> A person shall be entitled to a patent unless --
>
> (b) the invention was patented or described in a printed publication in this or a foreign country or in public use or on sale in this country, more than one year prior to the date of application for patent in the United States.

8. Claims 1, 4, and 15-20 are rejected under 35 U.S.C. 102(b) as being anticipated by Itoh et al.. Itoh et al. (herein referred to as Itoh), as cited by applicant, discloses in Figures 5(a) through 5(e): a semiconductor device and a method of manufacturing the semiconductor device with a metal wiring layer made of aluminum (31) formed on the substrate; a tensile stress insulation layer (411) is formed on the first metal wiring layer; a compressive stress insulation layer (412) is formed on top of the tensile stress insulation layer {column 4, lines 31-49}. Itoh also shows that a second metal wiring layer may be placed on top of the compression stressed insulation layer followed by a subsequent deposition of tensile and compression stressed insulation layers {column 6, lines 15-21}. Thus, the compressive and tensile insulation films are formed alternatively on top

of each other. The stressed insulation films could be made of PECVD (plasma enhanced chemically vapor deposited) PSG (phosphor silicated glass), BPSG (boron phosphor silicated glass), or SiO_2 {column 5, lines 10-14}.

Claim Rejections - 35 USC § 103

9. The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action:

> (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

10. Claims 5, 8, 9, 11, 12, and 13 are rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh in view of Maeda '546 et al.

Itoh substantially discloses the process as claimed but fails to show forming an insulating film by reacting a gas mixture including organic silane and oxygen containing gas by virtue of heating or "plasmanization". The examiner assumes that reacting the gas mixture by virtue of heating or by "plasmanization" refers to a process such as plasma enhanced CVD.

Maeda '546 et al. (herein referred to as Maeda '546) shows, in an analogous art related to a method for manufacturing a semiconductor device, that a PSG, BPSG or SiO_2 film is formed as a chemically vapor deposited insulating film when reacting gases containing organic silane (containing alkoxy compound of silicon, siloxane, alkylsilane, and the like) and/or ozone (O_3) are mixed at a temperature range between 350°C and 450°C {column 2, lines 59-67}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the insulation material of Itoh as the insulation material was formed in Maeda '546 because the reactant gases would have allowed for an SiO_2, PSG or BPSG layer to be formed on top of a semiconductor substrate.

11. Claim 7 is rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh in view of Maeda '546 as applied to claim 5 and further in view of Maeda '499 et al..

Itoh in view of Maeda '546 substantially discloses the invention as claimed but fails to disclose wherein the tensile stress insulation film is subjected to plasma irradiation after it is disposed on the substrate.

Maeda '499 et al. (herein referred to as Maeda '499) shows, in an analogous art relating to a method for reforming an insulating film, the results of an observation of two insulating film samples made of the same material wherein one sample was irradiated with plasma the other was not and the material properties were observed over a period of time. The sample that was irradiated with plasma was determined to have a tensile stress. The other sample, which was not irradiated with plasma, initially had a tensile stress but grew to develop compressive stresses over time. Thus, by reforming (irradiating with plasma) the insulating layer, a reduction in the change in the state of stress was achieved {column 7, lines 30-46}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to irradiate the insulating film of Itoh and Maeda '546 which was to be tensile because

plasma irradiation would have reduced the change in the state of stress in the lamina and thus increased the reliability, over time, of the device.

12. Claim 6 is rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh in view of Maeda '546 as applied to claim 5 above, and further in view of Bacchetta et al..

Itoh in view of Maeda '546 substantially discloses the invention as claimed but fails to disclose wherein the gas mixture contains an impurity containing gas.

Bacchetta et al. (herein referred to as Bacchetta) shows, in an analogous art related to a process for manufacturing integrated circuits which include layers of dielectric materials, doped SiO_2 with boron yields BSG (boro silicate glass), and doping SiO_2 with phosphorous yields PSG (phospho silicate glass) {column 4, lines 24-30}. Bacchetta also shows that doped (with B or P or both) SiO_2 is commonly obtained directly upon CVD deposition of the layer {column 4, lines 54-56}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to include impurity atoms such as B or P or both in the manner of Bacchetta into the SiO_2 found the in the insulating layer of Itoh and Maeda '546 to form the PSG and BPSG insulating layers because it is well known in the art to do so.

13. Claim 10 is rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh in view of Maeda '546 as applied to claim 5 above, and further in view of Morozumi.

Itoh in view of Maeda '546 substantially discloses the invention as claimed but fails to disclose wherein the film forming condition tool for adjusting the stress characteristics of

respective insulating films is at least one selected from the group consisting of a film forming temperature, type of gas, and a flow rate of gas.

Morozumi discloses, in an analogous art relating to a method of manufacture of a dielectric layer, forming two dielectric layers using nearly the same vapor phase deposition process. One of the dielectric layers has a compression stress, the other has a tensile stress. The dielectric layer in tension was processed in an inert carrier gas - the inert gas caused the second insulating layer to inherit a state of tension.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the tension stressed insulator layer of Itoh and Maeda '546 in the manner of Morozumi by adding an inert gas into the mixture because doing so would have been an obvious process optimization and use of available apparatus.

14. Claim 14 is rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh and Maeda '546 as applied to claim 11 above, and further in view of newly applied Itoh.

Itoh and Maeda '546 as applied to claim 11 above substantially discloses the invention as claimed but fails to show where an insulating layer is made compressive by changing one of the manufacturing parameters including frequency of plasma generating power, bias power applied to the substrate, film forming temperature, type of gas, and a flow rate of gas.

Newly applied, Itoh shows in the abstract that an insulator layer produced by PECVD is made compressive when a certain frequency of plasma generating power is reached.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the tension stressed insulator layer of Itoh and Maeda '546 in the manner of newly applied Itoh by adjusting the frequency because doing so would have been an obvious process optimization and use of available apparatus.

15. Claims 2 and 3 are rejected under 35 U.S.C. 103(a) as being unpatentable over Itoh in view of applicants cited Harriot et al., Maeda '546, and Morozumi.

Itoh substantially discloses the method as claimed but fails to show the stress (σ_L) in the overall stress-adjusted insulating film is adjusted according to:

$$\sigma_T = \sum_{i=1}^{n} (t_i \times \sigma_i)$$

or the overall (tensile or compressive) stress of the laminate is less than a certain, predetermined, value.

Harriot et al. (herein referred to as Harriot) shows in the abstract that a laminated insulating film made of individual laminae stressed either in tension or compression can be made to exhibit a stress of -50MPa to +50MPa. Harriot also shows that the thicknesses of the individual layers in the laminate contributes to the overall stress in the laminate {column 3, lines 11-13}.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to form the insulative laminate of Itoh within the stress limit (or as close to zero as possible) to avoid stress delamination problems and to ensure a reliable device.

Maeda '546 and Morozumi, as previously cited, show a means of adjusting the inherent individual stresses of insulating films through various processing techniques.

It would have been obvious to one of ordinary skill in the art at the time the invention was made to relate the variable processing parameters taught by Harriot (film thickness) and Maeda '546 and Morozumi (inherent and individual film stress through process optimization) together in such a way as to derive a formula to measure the overall film stress in the laminate.

Conclusion

16. Paper related to this application may be submitted directly to Art Unit 2814 by facsimile transmission. Papers should be faxed to Art Unit 2814 via the Art Unit 2814 Fax Center located in the Crystal Plaza 4, room 4C23. The faxing of such papers must conform with the notice published in the Official Gazette, 1096 OG 30 (15 November 1989). The Art Unit 2814 Fax Center number is **(703) 308-7722 or -7724**. The Art Unit 2814 Fax Center is to be used only for papers related to Art Unit 2814 applications.

Any inquiry concerning this communication or earlier communication from the examiner should be directed to **Kurt Eaton** at **(703) 305-0383** and between the hours of 8:00 AM to 4:00 PM (Eastern Standard Time) Monday through Friday or by E-mail via **Kurt.Eaton@uspto.gov**.

Olik Chaudhuri
Supervisory Patent Examiner
Technology Center 2800